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Article (Published Version)

Iskandarova, Marfuga, Dembek, Agata, Fraaije, Maria, Matthews, William, Stasik, Agata, Wittmayer, Julia M and Sovacool, Benjamin K (2021) Who finances renewable energy in Europe? Examining temporality, authority and contestation in solar and wind subsidies in Poland, the Netherlands and the United Kingdom. *Energy Strategy Reviews*, 38. a100730 1-14. ISSN 2211-467X

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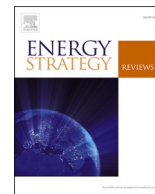
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# Who finances renewable energy in Europe? Examining temporality, authority and contestation in solar and wind subsidies in Poland, the Netherlands and the United Kingdom

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## ARTICLE INFO

### Keywords:

Energy finance

Subsidies

Financial mechanisms

Renewable energy

Marketisation

Institutionalization of financial mechanisms

## ABSTRACT

In this paper, we explore the development of financing and subsidies for renewable energy in three fossil-fuelled European countries: Poland, the Netherlands, and the United Kingdom. Financing for renewable energy is an existing arena involving multi-actor activities and practices that develop and implement (innovative) financial instruments to facilitate investments in renewable energy. This means that the paper focuses on different financial mechanisms – such as grants, awards, subsidies, crowdfunding, community bonds, ventures, social investment, as long as these funding instruments finance sustainable energy infrastructure and activities. The extent to which this is changing social relations and comes with new ways of doing, thinking and/or organizing is an empirical topic explicitly examined in the study. We first briefly define and conceptualize financial mechanisms and subsidies before explicating our mixed methods research design consisting of scoping, document analysis, 22 original expert interviews, and observational data from eight meetings and events. We then compare the recent history of solar and wind energy financing and subsidies in our three countries. These comparative cases reveal the temporality of subsidization, indicating fundamental changes in the patterns and logics of financing over the past two decades. They reveal shifts in authority and an expansion of actors involved in financing. They lastly reveal tensions and contestations in financing, including gaps in coverage and conflicts among stakeholder groups. We conclude with future insights for renewable energy diffusion, innovation, and policy.

## 1. Introduction

Financing, economic instruments and subsidies for renewable energy play a central role in the generation, commercialization and diffusion of low-carbon energy technology innovations [1–4]. Financial mechanisms can even be considered social innovations that are changing social relations and come with new ways of doing, thinking and/or organizing energy supply and use [5–7]. Financing for renewable energy involves multiple actors (from government, municipalities to charities, banks, investment funds, firms), activities and practices that develop and implement (innovative) financial instruments to facilitate resources for investment in renewable energy. Access to different financial and

investment mechanisms even allows households or cooperative members to undertake new roles in the energy sector.

Financing amounts for renewable energy are also expected to grow considerably over the next few decades as the global energy sector decarbonizes. For example, a decarbonized global energy sector is projected to need cumulative investments of at least \$110 trillion between now and 2050, representing an average of 2% of global GDP per year in perpetuity [8]. Similarly, the International Finance Corporation examined the national commitments submitted by 21 emerging market countries as part of the Paris Agreement, and found they needed \$23 trillion in investment if they would achieve their targets by 2030; the total amount of infrastructure investment required across all countries

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surpassed \$90 trillion [9].

Consequently, patterns of financing and subsidization are urgently needed to meet climate targets even as they alter the relations between actors, infrastructure, and institutions governing the energy system. By facilitating this change, financing trends pressure incumbents in the energy sector, forcing them to redefine their strategies in face of newcomers discovering new niches in previously homogeneous systems [10]. An important example is the new role of individuals who turn from passive consumers of electricity to prosumers engaged both in consumption, production, and exchange of the electricity [11–13]. This particular change demands not only access to the appropriate technologies and enabling legislation, but also the access to the financial resources necessary to cover the investment costs. The form and scale of these financial mechanisms has a decisive impact on who can take part in the transformation and who remains excluded. The evolution of these mechanisms provides important insight on the role of both outside institutional pressures and the institutional work conducted by field actors.

In this paper we empirically explore how three primarily fossil-fuelled European countries attempt to finance and support the maturation and diffusion of renewable energy technologies such as wind energy and solar power. We investigate the evolution of wind and solar financing and subsidies – such as grants, awards, crowdfunding, community bonds, ventures, social investment – in Poland, the Netherlands, and the UK. Our aim is to offer a confirmatory paper grounded in original empirical data from a comparative set of cases, rather than to offer a more exploratory approach emphasizing theoretical or conceptual development.

The article proceeds as follows. It first defines and conceptualizes financial mechanisms and subsidies and indicates gaps in the literature before explicating its mixed methods research design. It then compares the recent history of solar and wind energy subsidies in Poland, the Netherlands, and the United Kingdom. These comparative cases reveal the temporality of subsidization, indicating fundamental changes in the patterns and logics of financing over the past two decades. They reveal shifts in authority and an expansion of actors involved in financing. They lastly reveal tensions and contestations in financing, including gaps in coverage and conflicts among stakeholder groups. The paper concludes with future insights for both research and policy.

## 2. Literature review and background: Financing, subsidies, and renewable energy

The broad focus of our paper lies in the domain of literatures connected to both “financing” flows for clean energy as well as “subsidies” for specific renewable energy technologies. Financing refers most generally to the provision of funding to a person, project, policy, or enterprise. The closely related term of “finance” relates to the study of the system of money, investments, and other financial instruments, with the literature distinguishing between public finance (borrowing by and from governments), corporate finance (borrowing by and from firms), and personal finance (borrowing by and from individuals and households) [14]. A subsidy is closely related to financing, and refers to a form of support, assistance, or financial aid often flowing from a government or state provider to a person or company, with the most visible and common form a grant but numerous other types including tax incentives, price controls, and rebates [15]. Subsidies, for example, represent widely used policy mechanisms that can funnel public resources into neglected areas of infrastructure and development, accelerate innovation, or achieve various social or technological goals including low-income assistance or providing social safety nets [16]. In classic terms, subsidies can “supply push” improvements in technical performance via innovations in manufacturing or design, or they can “demand pull” improvements in the ability for households or institutions to purchase and use renewable energy technologies [17–19]. In simpler terms, subsidies are usually policy mechanisms that funnel public

resources; financial mechanisms are market-based mechanisms.

Over the past century, how energy systems, and renewable energy projects in particular, have been financed, owned, and operated has changed considerably. Throughout much of the early history of the electricity sector, both energy supply and transmission and distribution grids were run by state entities (state-owned companies) or monopolies. Much of this shifted in the 1980s and 1990s as privatization, liberalization, and electricity market restructuring altered financial flows from governments to private entities [20]; ownership also pivoted from states to firms and investors [21]. Whereas most renewable energy projects in the earlier era of monopolies and highly regulated markets were developed, owned, and financed by utilities or states, in the modern era of restructuring and liberalization, non-utility generators have entered the market along with independent power providers and a host of other distributed actors [22].

These shifts in market structure and ownership necessitated that renewable energy providers begin to build relationships with providers of capital and new forms of finance and investment [23]. This corresponded with a new spectrum of financial providers and types of finance, one that included actors as diverse as corporations, retail investors, hedge funds, private equity firms, banks, insurance companies, endowments and pension funds [23]. These new entities offer a diversity of financial options to renewable energy firms including feed-in tariffs and renewable portfolio standards [24], as well as debt instruments (loans and bonds) along with a wide range of different credit and repayment schemes and leverage options, one of the most attractive of which are “green bonds” [25]. McInerney and Johannsdottir [26] even go as far as to claim that “private finance will be a key enabler of the low carbon transition.”

Nevertheless, attaining finance adequate to both meet climate policy targets but also catalyze successful and self-sustaining renewable energy markets has been wrought with challenges. In 2009, developed countries promised to disburse at least \$100 billion in financing every year to promote climate change mitigation among developing countries through the Green Climate Fund; actual investment levels in 2019 have even surpassed this amount by reaching about \$455 annually [27]. Such figures may sound impressive, but it falls well short of the anticipated need for finance or investment five times greater at \$2.4 trillion [27]. Brunnschweiler [28] provocatively notes a paradox concerning the financing of renewable energy given that it requires smaller volumes of investment (due to more decentralized and modular installation capacities compared to large centralized power plants) but also sees more difficulty in securing finance. This is due partly to resistance from incumbent fossil fuel providers from investing in renewables, partly to the need for renewables to require longer term loans, and partly because many renewable energy firms are small and medium enterprises that banks find riskier to loan funds to.

Given these conundrums of finance and policy, many key questions and gaps remain in the literature. Hall et al. [29] argue that even though the amount of finance needed to promote low-carbon transitions will be large when accumulated over decades, peer-reviewed studies looking at financing patterns in practice are rare. Geddes and Schmidt [30] similarly argue that energy finance is a blind spot within most studies looking at renewable energy or low-carbon transitions. This is problematic, given that successful financing of renewable energy necessitates a stronger evidence base concerning the empirical relationship between different types of financial mechanisms and how they shape willingness for countries to actually invest in renewable energy [31]. In this way, renewable energy finance is a critically important object of scholastic inquiry given that closing the financing gap is a “major issue” for both energy transitions and climate policy [32]. Redirecting finance towards renewable energy could even be construed as one of society’s “grand challenges.” And yet our assessment of this literature reveals that most existing studies take a single country focus (e.g., United States, China), a single technology focus (e.g., offshore wind only, utility-scale solar only), and/or examine only a limited number of instruments (e.g., a

green bond, a feed-in tariff, an auction scheme in isolation).

In this paper, we seek to tackle these gaps head on by offering a comparative study of *multiple* financial mechanisms for *multiple types* of renewable energy that have contributed to the diffusion of wind and solar energy in *three* European countries – Poland, the Netherlands and the United Kingdom. Admittedly, “financial mechanisms” is not a phrase with a precise and widely understood definition; we suggest that it encompasses both finance, the ways in which activities are ‘financed’ through debt, equity, subsidies or grants (in the sense of [33]), and the revenue streams that the activities generate. Our main focus is on the former; subsidies for renewable energy are the key mechanisms here as government support for alternative sources of energy has been crucial for development of the sector in all three countries.

The decision was made to restrict the scope of the study by looking at the financial flows which have supported the creation of wind and solar photovoltaic (PV) energy generation. Solar and wind energy have a number of technical similarities compared with other sustainable energy sources (which helps keep the story of their financing manageable), but also some notable differences of relevance to social relations involved. Key similarities are:

- they produce no direct greenhouse gases in operation [34];
- they are variable energy sources, unlike baseload plants, and require grids that can handle greater degrees of intermittency [35];
- they harness ambient flows of energy in their surroundings at zero marginal cost, which means much of the ongoing cost associated with an installation is cost of the capital used to finance its construction [36];
- wind and solar are well-developed technologies and have gone through all stages of commercialization – from early pilot developments to wide adoption and commercialization [17,18,37–40, 75]. This makes them well placed to trace the evolution of subsidies and financial mechanisms, which were obviously evolving as the technologies matured;
- compared to other systems (e.g. hydroelectric dams, natural gas turbines, coal boilers, steam engines), the maturation of these technologies has occurred over roughly similar timeframes with notable cost reductions (as well as improvements in learning) over the last ten years, or projected into the future [17,18,41,42];
- these cost reductions can not only improve technical performance and efficiency, more deployment can also lower the cost of capital itself [43].

Notwithstanding these defining attributes, solar PV, onshore wind and offshore wind differ markedly in their economies of scale, and this is reflected in the distribution of installation sizes that we see for each technology. For example, in the UK and in Poland while there are many solar farms above 5 MW, there are also hundreds of thousands of solar PV systems under 10 kW capacity, many of which are installed on individual homes and in many cases owned by individual households. In the UK, there are thousands of onshore wind installations, ranging from individual turbines to the 539 MW Whitelee Wind Farm in Scotland (the largest in the UK). There are tens of offshore wind farms. With the exception of pilot schemes these are above 60 MW and the largest to date is 1200 MW. At the same time in Poland, the development of wind onshore installations was virtually stopped in 2016 with so-called “Anti-Wind Turbine Act” after few years of dynamic development and reaching of 6000 MW of total capacity. In the Netherlands, greater community awareness over environmental concerns, the presence of grassroots initiatives, and a generally stronger level of trust in renewable energy companies and institutions has also driven an expansion of the sector [44,45]. Dutch planners have particularly focused on developing onshore wind, residential solar energy, and bioenergy [46].

Perhaps equally important, wind and solar are ideal to study from a financial mechanisms and subsidies perspective because they require far *more* financing than fossil fuel facilities per unit of installed capacity. As

Schmidt [36] notes, wind and solar in particular are more capital intensive than their fossil-fuelled counterparts, they are less operations or fuel intensive, and they require more capital investment. Indeed, Fig. 1 shows that compared to fossil fuels, renewable energy sources need far, far greater amounts of finance, in some cases up to five times more than coal and four times more than gas fired power plants. This makes them ideal candidates to study when it comes to evaluating the efficacy and dynamics of financial instruments and subsidy flows. Wind and solar may also be more dependent on foreign direct investment, especially in emerging or less established markets, than other forms of energy technology [47].

Moreover, as the ‘fuel’ is free and maintenance relatively inexpensive, most of the labour and materials used to produce solar or wind power are deployed before the generation asset is commissioned, and a substantial part of the revenue will go towards the cost of the capital (both debt and equity) used to reach that point. Following the UNEP ‘Global Trends in Renewable Energy Investment’ reports it is useful to divide the creation of a new renewable energy generation asset into two main phases separated by the ‘final investment decision’ (FID) at which time the necessary financial commitments have been made for construction to begin [48].

Reaching the FID involves (among other things) the identification of a suitable site; establishing the rights required to build and connect the asset from the owner of the site, planning authorities, etc.; finding sources of financing for construction; establishing contracts necessary for the construction, connection, and operation of the asset. After the FID, construction is generally lower risk. Equity in the project could potentially be issued or change hands in an acquisition at any stage. Given the changing type and level of risk over the life of a project, it is also common for projects to be refinanced.

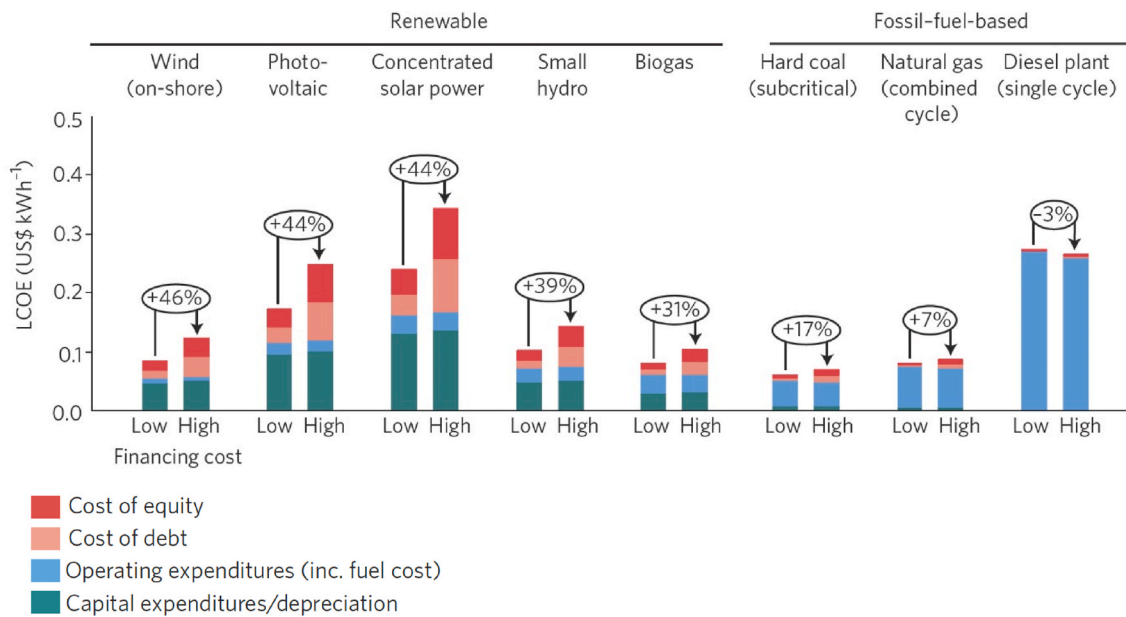
Once the asset has been commissioned, the revenues it receives typically involve the sale of electrical energy which might be done on a transaction basis in a market, but which is often done through longer term power purchase agreements (PPA). In addition, revenue may be supported by a variety of subsidy mechanisms (e.g. a Feed-in Tariff). The revenue streams that will be available are typically of great interest to a project’s financial backers, for obvious reasons.

In the sections to come, we will explore how three European countries—Poland, the Netherlands, and the United Kingdom—utilize a mix of these different policies to support wind and solar energy facilities. In order to make renewable energy more attractive to financial providers, policy instruments often act to increase returns, reduce risks, or stimulate new markets or sources of revenue [2]. Policy instruments thus become coupled to financial mechanisms. Table 1 summarizes financing mechanisms and subsidies for renewable energy that we will explore in our three countries. They fall into two broad categories: (1) direct subsidies and other EU/government-backed financial instruments; (2) market-based mechanisms. Some mechanisms are universal (e.g. crowdfunding), some are only appropriate in specific economic and country contexts (e.g. EU funding in Poland).

But first, it is important to better explain how we selected our three countries and how we collected original data for our analysis.

### 3. Comparative and mixed methods research design

To explore the evolution of renewable energy subsidies in Europe, we relied on a comparative case study approach. Three specific countries were chosen because they relate to the aims and objectives of a recently funded Horizon 2020 project by the European Commission which specified such a focus in its approved proposal, but this also possesses the advantageous ability to draw from author teams within each of the three countries and also familiar with local debates, policy documents, and language sources. These three European countries have the benefit of differing in terms of location (west and east), energy markets (dominated by gas, renewables or coal) and different climates. Table 2 offers a high level overview of some key indicators for each of these



Source: Schmidt (2014).

**Fig. 1.** Financing expenditures, equity, and debt ratios for various energy systems.  
Source: [36].

**Table 1**

Overview of renewable energy subsidy and financial mechanisms examined in this study. Source: compiled by the authors.

Country	Direct subsidies and other EU/government-backed financial instruments	Market-based mechanisms
<b>Poland</b>	European funds, i.e. under the Operational Program "Infrastructure and Environment"; Iceland, Lichtenstein, Norway's financial support (subsidies and loans) Green Investment Scheme (connected to the EU Emission Trading System) Green Certificates (certificates of origin) Auction mechanism (replaced Green certificate) Net-metering (replaced FiT before it came to force) My Electricity programme (subsidy programme funded through the Green Investment Scheme) Tax relief scheme	Private funds & investments (e.g. "collective prosumers", "virtual prosumers") Preferential bank loans (e.g. through Bank for Environmental Protection (Bank Ochrony Środowiska S. A., BOŚ), Bank Gospodarstwa Krajowego) Crowdfunding Green bonds
<b>Netherlands</b>	MEP, SDE, SDE+, SDE++ Regional Energy funds State loans from promotional bank Invest-NL	Crowdfunding Private funds & investments
<b>United Kingdom</b>	Renewable Obligations (RO) Feed-in Tariff (FIT) Contracts for difference (CfDs) Smart Export Guarantee (SEG) (in GB) Rural Community Energy Fund Urban Community Energy Fund Tax relief schemes (e.g. EIS, VCT, SITR)	Private funds & investments (e.g. institutional investors, Green Investment Bank, Cooperative bank Triodos) Crowdfunding, including Community Municipal Investment (CMI) model Power Purchase Agreements (PPAs)

**Table 2**

Core sociodemographic, energy and climate change data for our three selected countries.

	Poland	Netherlands	United Kingdom
<b>Population (millions of people) <sup>a</sup></b>	38.39	17.35	66.834
<b>Gross Domestic Product (GDP, adjusted to purchasing power parity, millions of US\$) <sup>a</sup></b>	566.71	840.99	3,255,483
<b>Total primary energy supply (million tons of oil equivalent) <sup>a</sup></b>	105.8	72.93	175.21
<b>Electricity final consumption (Terawatt-hours) <sup>a</sup></b>	166.8	117.1	325.93
<b>Total greenhouse gas emissions (million tons of carbon dioxide equivalent) <sup>b</sup></b>	414.6	195.9	585.8
<b>Total renewable energy production (in Gigawatt-hours) <sup>c</sup></b>	21,651	18,884	108,131

<sup>a</sup> International Energy Agency [49].

<sup>b</sup> World Bank [50]; and.

<sup>c</sup> International Renewable Energy Agency [73].

Source: Authors, based on most recent data from the

three countries. Extremely relevant for our study, all three countries also have very different energy markets. Poland is a transition economy; the UK has a mature market-based financial system; the Netherlands is more of a 'bank-based' financial system. We maintain this offers an authentic range of countries in terms of their geographic location, energy sources, and climatic conditions.

With three countries selected, we then executed a mixed-methods research design consisting of four distinct methods of data collection which ran in parallel:

- 1. Scoping:** Initial scoping was conducted amongst colleagues across a large-scale European project (blinded in acknowledgments) concerning which social innovation initiatives they knew of in the realm of finance and subsidization. Further research through search



engines led to a longlist of finance/subsidy/tax/fiscal instruments and initiatives in each of the three countries.

2. **Document/literature review:** A review of the literature and documents on this topic was conducted in few stages. First, we used Google, Google scholar and ScienceDirect and Nexislexis. Search queries were: ‘finance renewable energy’, ‘financing energy transition’. After the areas of research became clearer, more specific search queries were used (e.g. ‘invest-nl’, ‘kfw nederland’, ‘crowdfunding’, ‘feed-in tariff’, ‘ulga termomodernizacyjna’, ‘Mój Prąd’). Given the breadth of the subject, rather than conducting a systematic review (i. e., reviewing all matches for specific search queries), we took an explorative approach and further drew on the interviews to identify the trends for each country and looked at the relevant documents such as the UNEP/Bloomberg financing renewable energy reports, Green Investment Bank reports, the reports produced by trade associations (e.g., Community Energy England, Solar Trade Association), the government reports etc. Following the initial document review, more specific queries were made based on these documents.
3. **Interviews:** 22 interviews were conducted (See Table A1 in Appendix) by selection and personal invitation through e-mail and in one instance through an open call on LinkedIn in 2020 and 2021. The initial approach was to snowball through these interviewees. However, we wanted to grasp the breadth of innovations and therefore interviewees were selected more specifically for their diversity of knowledge in this topic. Interviews lasted generally 60–90 min and involved a robust mix of different stakeholder types, such as: municipality employees, crowdfunding entrepreneurs, civil-society actors, national government employees, bank fund managers, scholars. Our specific research interview questions and analytical protocol are shown in Table A3 in the appendix. The interviews were semi-structured, lasting between 30 and 180 min, and each adhering to the general interview script but also dynamic enough to facilitate questions and answers. For both ease of reference and to highlight our interview data, we have placed all direct quotes or paraphrased analysis from the interviews in italics throughout the manuscript.
4. **Observational data from meetings and events.** To supplement the document analysis and interviews, the authors also attended eight events—all large, public meetings related to either renewable energy and/or financing and subsidies—from 2019 to 2020. These events were chosen because they were fairly large (a minimum of 10 participants and a full program), at a high level (often attended by senior policymakers or intermediaries present), open to wide range of participants (with representatives from energy and equipment suppliers, regulators, civil society, etc.) and verifiable (most had full transcripts, background materials and a briefing booklet). The events attended are shown in Table A2 in the Appendix. When visiting each of the events, the authors performed naturalistic observation, taking notes about the meeting and also generating a “transcript” of key themes, areas of contention, and questions from the audience. The observational evidence collected from these events is useful for aiding the understanding of contextual conditions and deeper dimensions difficult to collect in static sources such as written texts [51]. This observational data was used as an additional source of information for understanding the issues around renewable energy finance.

Despite these efforts at triangulation (across mixed methods), our study does have certain limitations in terms of a number and types of actors represented. Additionally, the Covid-19 pandemic challenged the research limiting the amount of participant observation that was possible which were mainly used to learn more on the topic of financing. Moreover, due to the explorative nature of our study, we have not conducted a systematic review of each case study. Therefore, a limitation of this study is that the financing and subsidy mechanisms discussed are dependent on the specific networks, context and knowledge of the stakeholders we interviewed. Further analysis, which we did not have

the space to conduct, on issues such as spatial differentiation, urban and rural distinctions, cultural embedding, and historical market factors behind the patterns identified in our three countries would certainly be warranted by future research.

#### 4. Results: Comparing renewable energy subsidies and financial instruments in three countries

This section presents our initial “Results,” drawn from all four of our methods (scoping review, policy review, interviews, observational data) and organized as a chronological narrative of how subsidies and financial mechanisms for wind and solar have emerged and changed over the past two decades. We will offer a more thematic discussion of each case in Section 5 to come, after we summarize the chronology of our three cases.

##### 4.1. Poland: From vacuum to abundance

Our chronology introduces the history of subsidies in Poland from 1989, but focuses mainly on the period of 2015–2020 – the time of a relative acceleration of the investment in renewable energy in Poland, resulting in the growing proportion of energy from renewable sources in the national energy mix. Generally, the country morphed from having almost no subsidies in 1989 for renewables to deploying a strong array of traditional subsidy mechanisms towards renewables by 2020 (See Fig. 2).

The first phase from 1989 to 2004 saw a vacuum or absence of funding mechanisms supporting RE. Before 1989, Poland was proud of its coal-based energy system, even if it faced serious problems in 1980’s. The project of building the first Polish nuclear power plant was abandoned in 1989, leaving the coal power plants almost the sole source of electricity. In 1989 the process of political and socio-economic transformation started in Poland, and the so-called Roundtable Talks, a dedicated working group focused on ecology (ecological sub-table) was set. As our interviewees point out, *for twenty years following the 1989 transformation, the official, political and legal actions towards energy transformation and decarbonization were almost totally absent. For years, energy was publicly and politically perceived as a key national safety issue, hence public debate focused mainly on the problem of energy dependence (gas import from Russia). The funds for renewable energy were virtually inaccessible.*

A second phase from 2004 to 2015 saw public subsidies for energy efficiency from EU funds and debates on the Renewable Energy Sources (RES) Act. After Poland joined the EU in 2004, the issues of environment and climate protection slowly started to take more prominent place in public discourse and in policy-making. The main stream of funds devoted to this goal came from dedicated EU funds. The most important institution responsible for management and distribution of public funds for renewable energy and energy efficiency projects is The National Fund for Environmental Protection and Water Management (NFEPWM) (PL: Narodowy Fundusz Ochrony Środowiska i Gospodarki Wodnej, NFOŚiGW). It has been operating since 1989, first as a special purpose fund, and since 2010 as a state legal entity. Its main objective is to provide financial support to large projects aimed at environmental protection and water management. Central NFEPWM, along with 16 independent (subordinated to voivodship administration) sub-funds with similar goals (Provincial Funds for Environmental Protection and Water Management, PFEPWM), constitutes the core of the Polish system of financing environmental protection projects.

Since 2010, NFEPWM has organized the Green Investment Scheme (GIS), a derivative of the Emissions Trading System (ETS). Until 2019, it anted PLN 530 mln in loans and PLN 586 mln in subsidies, resulting, among others, in improvement in thermal efficiency of 1700 public buildings, construction of 17 biogas power plants, and connection of 7 wind power plants to the network. During this time, Poland has also come to support “Green Certificates”, or certificates of origin. The

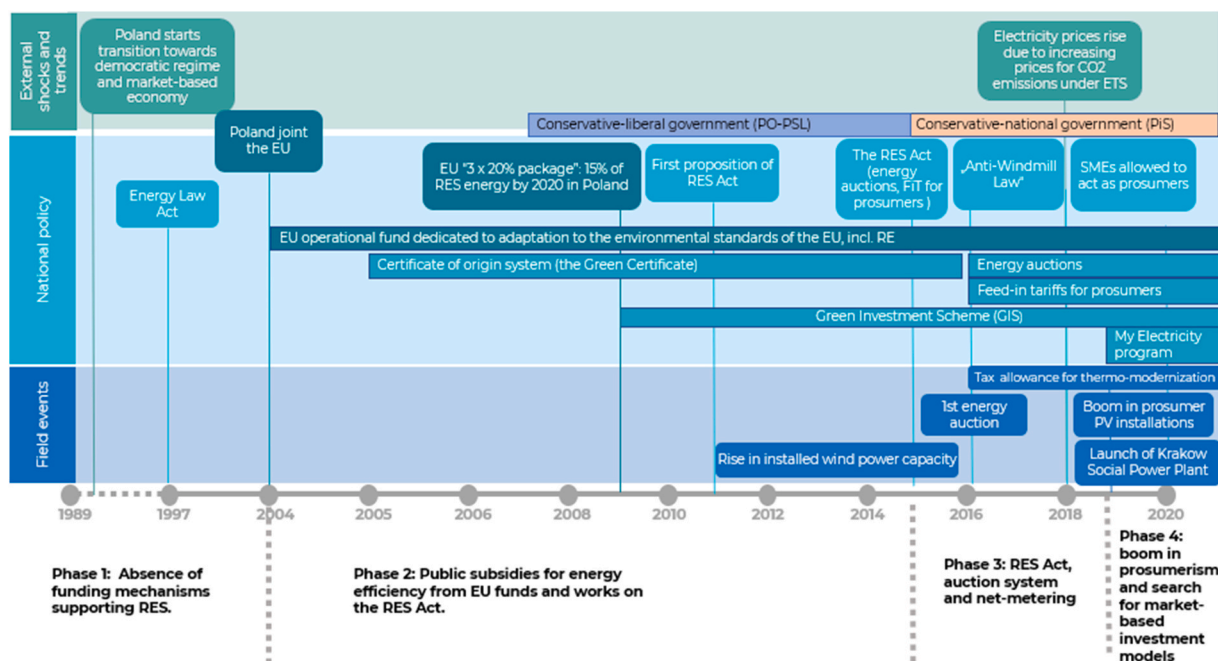


Fig. 2. A timeline of renewable energy subsidies and financing in Poland, 1989 to 2020.

system was based on the obligation imposed on energy sellers to obtain and submit to the President of the ERO (Energy Regulatory Office; pl: URE, Urząd Regulacji Energetyki) a certain number of certificates of origin of electricity generated from renewable energy sources (so-called "Green Certificates"), or to pay a substitute fee. That is, producers of energy from renewable sources had guaranteed the purchase of the energy they produced. The system was regulated under Energy Law. In this period, there was no dedicated act regulating specifically the development and operating of renewable energy sources. The first version of the RES Act was proposed in 2011 and were debated for years, while civic interest and pressure to allow investment in renewable energy grew.

A third phase from 2015 to 2019 saw passing of the RES Act and the emergence of auctions, net-metering, and rising electricity prices. After years of discussion, RES Act was finally accepted in February 2015. It introduced the number of new funding mechanisms. First of all, the auction system replaced the Green Certificates system. Second, the Act enabled prosumerism. In its first version, it introduced the feed-in tariffs system. However, feed-in tariffs never started to be in force because the next government, that took over from November 2015, withdrew this policy measure and replaced it with net-metering. The RES Act came into force on January 1, 2016; since then, it has been amended several times. To a certain extent, the RES Act finally responded to a growing interest and lobbying towards creating conditions for prosumers in energy (a category non-existent in Polish legal and energy system before).

While the RES Act opened the system for prosumers' participation, it is worth stressing that another governmental regulation, the Act on Investments in Wind Farms, called "the anti-windmill law" by the wind industry, accepted in 2016, virtually frozen the sector of wind power plants. According to the act, it is possible to build a new wind farm at a distance of not less than 10 times its height (including blades) from residential and mixed buildings and areas particularly valuable from the natural point of view (e.g. national parks, landscape parks, reserves). It is not possible to expand the existing windmills that do not meet the distance criterion - only their renovation and works necessary for their proper use are allowed. The act also introduced an increase in taxation of new and existing wind farms. The new regulations did not apply to wind farms with a capacity of up to 40 kW, i.e. they do not apply to micro-installations, and also do not apply to offshore wind farms.

A final phase from 2019 to today has seen a boom in prosumerism and active search for market-based investment models. The year 2019 signalled the new phase in the field of funding and investment mechanisms in renewable energy in Poland by introducing the number of incentives for individuals willing to invest in PV micro-installations.<sup>1</sup> In July 2019 the Ministries of Energy and of the Environment launched the program "My Electricity" dedicated to households who want to become prosumers.<sup>2</sup> It is a public subsidy programme managed by NFEPPM and funded through the Green Investment Scheme. It has been operating from July 2019 until December 2020 and is likely to be prolonged. It allows individuals to receive the subsidy of PLN 5000 (~1200 EUR) for a small (2 kW–10 kW) installation of PV on their own roof or grounds. Until October 2020, 173,000 applications have been submitted, with an average number of 800 applications per day. This has seen solar energy grow in Poland significantly, as Fig. 3 shows. Thanks to these programmes, for the first time Poles became renewable energy investors on the mass scale.<sup>3</sup>

Another important renewable energy financing mechanism is bank loans, including dedicated loans supported by public funds and fully commercial loans for investments. Such loans are granted by both commercial and special banks, such as Bank Ochrony Środowiska (BOŚ) (Bank for Environmental Protection). The above-mentioned initiatives are rather traditional when it comes to the mechanisms they employ; nevertheless, they support the new ways of thinking, acting and organizing about energy by enabling new actors to take new roles in the energy system, but also by forcing incumbents (mainly, energy producers and grid operators) to redefine their strategies in face of newcomers' actions. Simultaneously, the instruments dedicated for the renewable energy support evolved from certificates of origins to auction system and from Feed-in Tariffs (accepted by the parliament, but never operating) to net-metering. Finally, in the last years, we can also see the

<sup>1</sup> <https://www.documents.clientearth.org/wp-content/uploads/library/2020-05-08-od-zera-do-gigawata-ewolucja-polskich-regulacji-prosumentkich-ce-pl.pdf>.

<sup>2</sup> <https://www.gov.pl/web/srodowisko/rusza-program-moj-prad>.

<sup>3</sup> <https://energyre.pl/pl/2019/09/novelizacja-ustawy-o-oz-e-co-warto-wiedziec-na-temat-zmian/>.

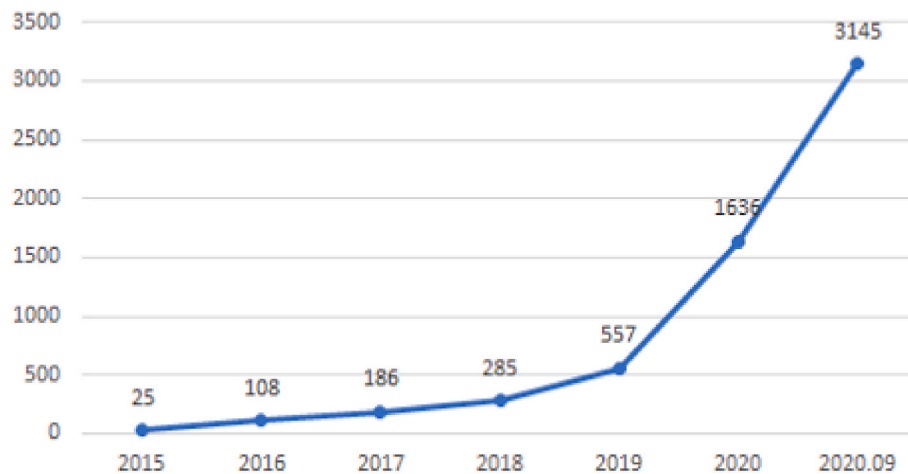


Fig. 3. Growth of solar power installations in Poland (in MW) 2015–2020.

growing efforts to develop market-based financial mechanisms, such as investment-based crowdfunding, EPC (energy performance contracting), ESCOs (Energy Service Companies), and innovative instruments such as green bonds [52] and local investment cooperatives [53]. Despite the fact that they are marginal in quantitative terms, they may signal the direction of the sector's development.

#### 4.2. Netherlands: The rise and fall of 'mad Hank'

In 1996 to 1998 the EU started liberalization of the energy sector with the EU's First Energy Directive (1996), which was transposed into the Electricity and Gas Act of 1998 in the Netherlands (See Fig. 4). Since then, the relations between actors in the energy sector changed radically, shifting ownership from the state to market actors. This marked a new role for the government by stimulating the emerging market through subsidies.

The 1990s also saw major shift of attention towards environmental concerns, expressed through the treaty of Maastricht (1993), which made the environment a formal policy domain, and the treaty of Amsterdam (1997), which enforced environmental protection to be embedded in all EU sectoral policies in order to promote sustainable

development. Together, the Electricity and Gas Act and the Treaty of Amsterdam and Maastricht prescribed a radical shift away from a state-based fossil system, to a market-based system committed to sustainable development.

These shifts were met with a cascade of subsidies emerged at the start of the new Millennium, aiming to stimulate the production of renewable energy. The chosen mechanism was to subsidise the difference between the electricity price (the profits of a project) and the cost price of the technology (the costs of a project) and thus to take away the 'unprofitable top' of renewable energy investments as compared to their relatively profitable fossil competitors. This subsidy mechanism was called the Stimulation regulation Sustainable Energy Production (NL: Stimulerende Duurzame Energiesubsidie, SDE). The SDE subsidy was later replaced by the SDE+ (2011) and SDE++ (2020) subsidies. Between 2020 and 2032, the Ministry of Economic Affairs and Climate has set aside €36.9 billion for the SDE and SDE (+/++) (Algemene Rekenkamer, 2019).

In the second decade of the 2000s, decentral governments and citizens became increasingly important as financiers of renewable energy. Around 2010, local and regional governments sold their shares in their local energy utilities, enabling them to invest substantially (tens of

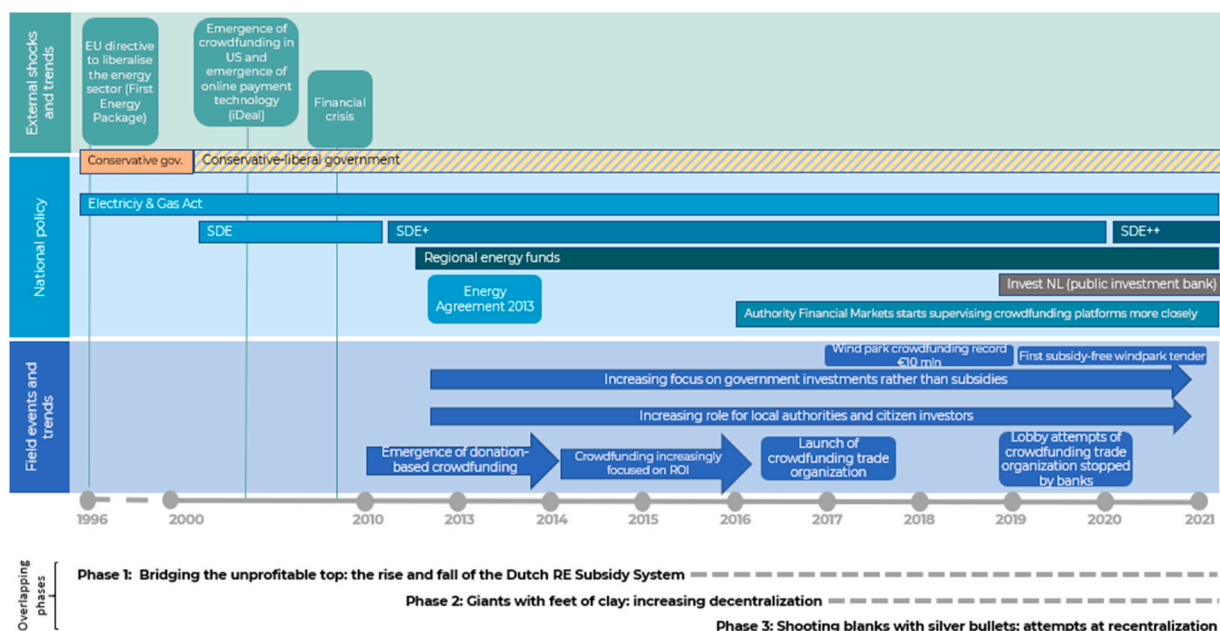


Fig. 4. A timeline of renewable energy subsidies and financing in the Netherlands, 1996 to 2021.



millions) in renewable energy projects through newly instated regional energy funds. Some of the sales of these shares were specifically labelled as ‘energy-related’ and were to be invested in the local and regional energy transition. In the words of one interviewee: *“It was crazy. We suddenly had 1 billion Euros on the bank account.”* Between 2012 and 2018, the regional energy funds supplied 400 million euros of financing to about 700 renewable energy projects.<sup>4</sup> The regional energy funds implied a considerable change in the role of local/regional governments: from being shareholders in a utility, focusing mainly on subsidization, they now had access to funds for energy-labelled loans.

Decentral governments started shifting away from subsidization, towards investment in renewable energy production. Against the background of ongoing privatization of the energy sector, and in the aftermath of the financial crisis of 2008/2009, subsidization had started to be considered as too expensive. As outlined by an Alderman of the city of Amsterdam in 2012: *“We have become more business-minded. We shouldn’t be ‘mad Hank’ who just spends money. We also want to see revenues”* [54]. Consequently, 2014 to the present indicates decreasing subsidization on a decentral level. Nationally, subsidization was also decreasing because of technological advancement and market effects. The SDE + subsidy for solar panels decreased from ca. 0.14€/kWh in 2014, to ca. 0.10 €/kWh in 2019. The SDE + subsidy for wind parks at sea marked a considerable drop over the years, from 9.15 €/kWh in 2013, to 0 in 2018 when Chinook/Vattenfall won the first tender without subsidy for wind park Dutch Coast (south) (NL: Hollandse Kust (zuid)) III and IV (See Fig. 5).

The period between 2010 and 2016 marked a substantial increase in financial participation of citizens in the energy transition through energy cooperatives and crowdfunding campaigns. This can be related to a number of policy changes. The 2013 Energy Agreement accorded citizens an important role as in realizing the energy transition through collectives (i.e. energy cooperatives) or individual efforts. Consequently, from 2013 to 2014 onwards, regional and local governments started to give citizens opportunities for (financial) participation in renewable energy projects as part of their building and environment permits.

Meanwhile, the ongoing professionalization of crowdfunding led to various record-breaking crowdfunding levels, with 7.7 million euros of crowdfunding raised by cooperative Zelfstroom in 2014, and 10 million by Windpark Krammer in 2018.<sup>5</sup> One aspect of the professionalization was the setting up of a crowdfunding platform trade organization, which lobbied for the needs of crowdfunding platforms and against the dominance of the Dutch banking sector. They hoped to instate a mechanism that required banks to refer loan rejected entrepreneurs to alternative financiers, inspired by a similar mechanism in the UK. However, this mechanism was stopped by the lobby of the existing financial sector. The Authority Financial Markets (AFM) started treating crowdfunding platforms as professional players in the financial sector around 2016 and started to keep them under closer supervision. Later, in line with the wider trend to move from subsidization towards investment, a renewed interest in a national promotional bank, which could provide high-risk investments to projects that have high upfront costs, resulted in Invest-NL (founded in 2020).

#### 4.3. United Kingdom: from ‘the greenest government ever’ to a bonfire of subsidies

Our chronology of subsidies in the United Kingdom reveal how the most important policies and policy-making have been happening at the national level (see Fig. 6). This manifested, first of all, in subsidy

schemes for renewable energy. At launch the subsidies usually played an enabling role; their closure was an impeding factor for the renewable energy sector.

Our chronology begins with the Renewables Obligation (came into effect in 2002), which replaced the Non-Fossil Fuel Obligation (NFFO)<sup>6</sup> as the primary revenue support for renewable generation. This scheme required electricity supply (i.e. retail) companies to surrender Renewable Obligation Certificates (ROCs) covering a certain percentage of the energy supplied to customers or pay a penalizing buy-out price. This was intended to create a demand, and a market price, for ROCs, which were granted freely to owners of registered renewable generation assets according to the amount of energy these produced.

These efforts paved the phase for a phase of ‘The greenest government ever’ from 2010 to 2015. Following further work on implementation, the Feed-in Tariff (FIT) scheme was launched in April 2010. It supported renewable generation installations of up to 5 MW capacity by mandating that electricity suppliers provide an inflation indexed payment per kWh generated (and an additional payment per kWh exported to the grid) for a twenty-five year period following registration with the scheme. By the end of the FIT scheme’s first year, 30,201 installations were participating in the FIT, of which 29,556 (77.7 MW) were Solar PV, 1339 (18.9 MW) Wind, and 203 Hydro (9.9 MW) [55].

During this time, solar energy in particular took off. As Fig. 7 shows, until the end of 2013, most solar PV capacity installed was supported by the FIT and consisted of installations under 4kW in size — the scale typical of residential rooftop installations. Indeed, the vast majority of FIT installations by number were domestic Solar PV systems. Hundreds of thousands of households became grid connected electricity generators during the first few years of the scheme, some supported by ‘rent-a-roof’ schemes offered by private companies such as HomeSun, which had already launched its scheme by July 2010 [56]. Supported by the high initial level of the FIT, these were schemes in which the company installed roof-top solar panels at no (or very low) cost to the homeowner, retaining ownership of the hardware and receiving the FIT payments. The homeowner meanwhile benefitted from free use of the electricity produced.

During the period 2010–2014 the overall trend for community energy was very much influenced by government subsidies i.e. FIT scheme. According to one interviewee, before it came in, community groups were doing mainly energy efficiency work, but that *“flipped around a bit with FIT which gave people a business model to do renewables”*; *with the end of FIT that changed again* (UK07). Moreover, two effects of the financial crisis were favourable to raising money for projects through community shares — *“the financial crash [...] led to a decline in trust in the banks and very low interest rates. People were therefore open to the idea of community shares”* [58]; p. 14).

The coalition government had made some commitment to support community energy: the Rural Community Energy Fund (RCEF); a “community energy revolution in the UK” pledge, followed by Community Energy Strategy 2014 [59] and launching Urban Community Energy Fund (UCEF) in 2014 which, like the RCEF, offered grants and loans for pre-planning development work [60]. After the Community Energy strategy 2014 was published by the Department of Energy and Climate Change (DECC), the government was encouraging local authorities to support community energy projects, and to be more active in energy provisions. This led to the increasing role for local authorities in financing renewable energy projects. Institutional investors also played a big part after 2014, e.g. UK local authority pension funds, insurance and pension companies.

Along with setting up the Green Investment Bank (launched in 2012), the coalition government had been developing a programme of

<sup>4</sup> <https://www.greendeals.nl/nieuws/regionale-energiefondsen-en-invest-nl-pakken-financiering-grote-energieprojecten-samen-op>.

<sup>5</sup> However, institutional investors (generally large scale investors e.g. pension funds, insurance institutions) are currently not participating in crowdfunding due to the substantial transaction costs involved in investing relatively smaller sums across multiple projects.

<sup>6</sup> The NFFO was the UK’s first price support policy for renewable generation and was introduced by the Electricity Act 1989 which also privatised the electricity supply industry [68].

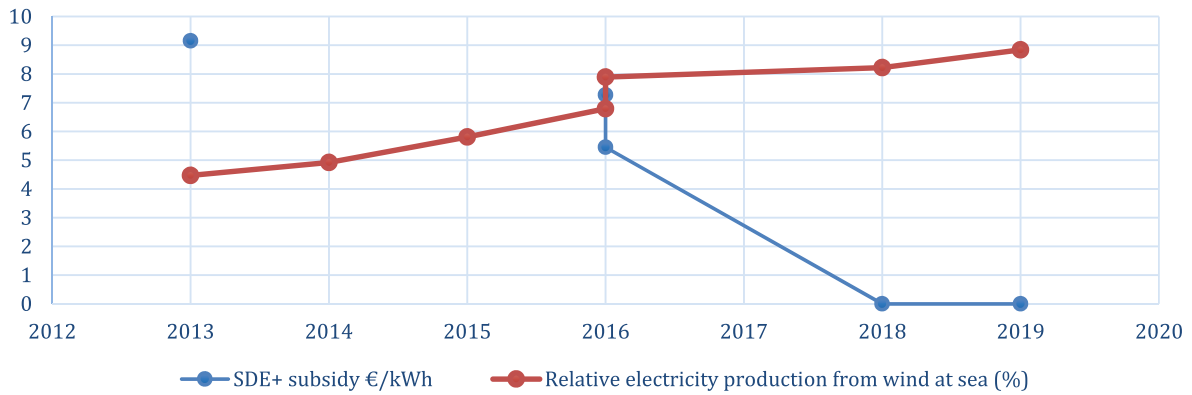


Fig. 5. SDE + subsidy for wind parks at sea and the share of electricity production from wind. SDE + subsidy for wind parks at sea decrease over time, while the share of electricity production from wind slowly rises. \*relative to total electricity production in the Netherlands, in % of the end usage. Data: CBS, 2020.

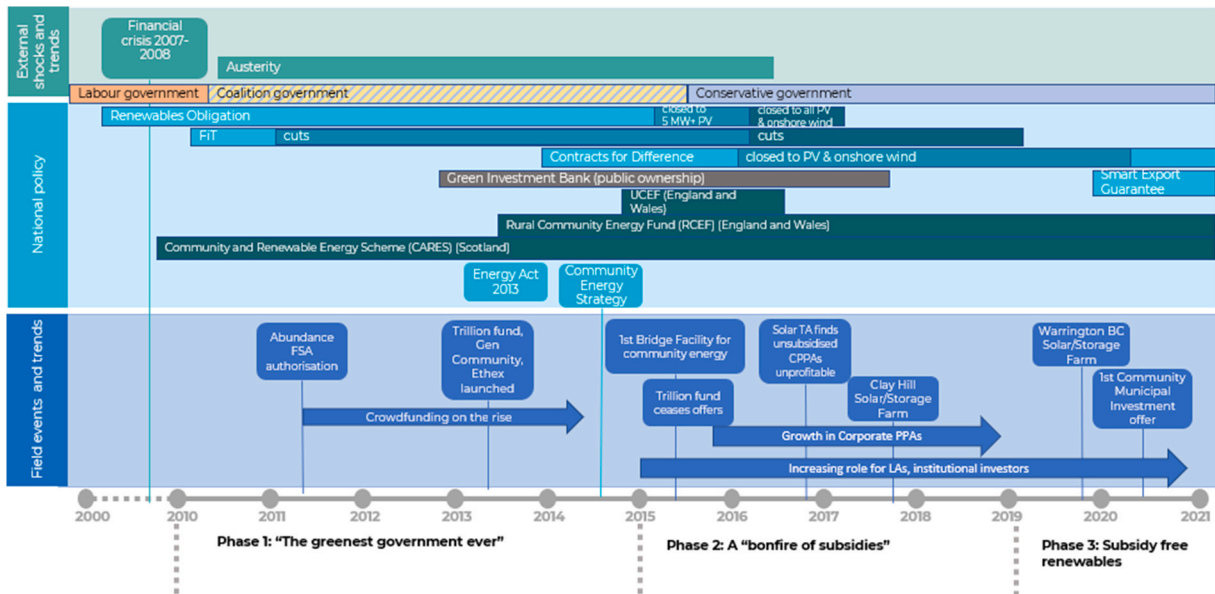


Fig. 6. A timeline of renewable energy subsidies and financing in the United Kingdom, 2000 to 2021.

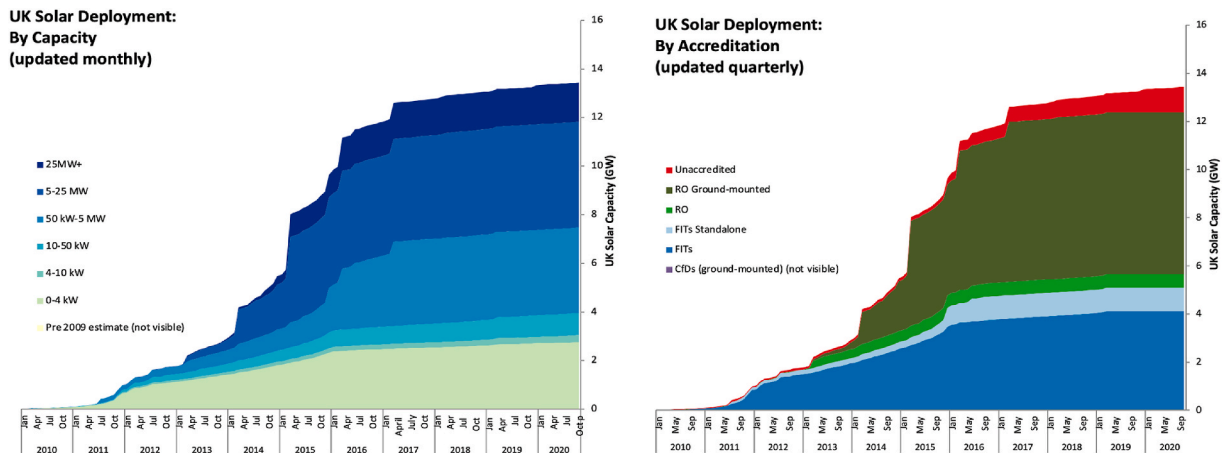


Fig. 7. Cumulative Solar PV capacity in the UK by installation size and support mechanism. Source: Modified from [57].

'Electricity Market Reform' (EMR) which culminated in December 2013 with the assent of the Energy Act 2013. Along with a carbon price floor and emissions standards this introduced a Capacity Market and 'Contracts for Difference' (CfD). CfDs were intended to replace the Renewables Obligation as the main state support for deployment of large scale renewable and nuclear generation. Attracting new kinds of investor to energy generation infrastructure, including institutional investors, was a key goal in the formulation of this policy [10,61,62].

While the government worked to channel new investment into renewable energy with the GIB and EMR, a quite different market for investment in renewables was being developed with the emergence of crowdfunding platforms – a mechanism for raising capital from large number of small investors. In 2011, a crowdfunding start-up, Abundance Generation, became the first platform to receive authorisation from the FSA; it was also the first platform in the UK focused on raising capital for renewable generation projects. This was followed by other platforms – the Trillion Fund, Gen Community, Ethex.

However, from 2015 to 2019 a policy change marked a new phase in RE financing. It was widely reported in November 2013 that Cameron had told aides he wanted to "get rid of all the green crap" in reference to the various levies on energy bills which had been introduced to support the greening of the energy sector [63,64]. While veracity of the quote was disputed by Downing Street, it does crudely describe the policies the government would actually adopt under Cameron's leadership over the next few years, particularly after the Coalition was replaced by a Conservative government in May 2015.

This led to a "bonfire of subsidies". A series of policy changes significantly cut subsidies for the development of new onshore wind and solar PV installations at all scales. In a sign of things to come, the government had announced in May 2014 that the RO would close to solar PV installations over 5 MW at the end of March 2015, two years earlier than planned [65]. While the export tariff would be unchanged under the proposals, the cuts to the generation tariff were between 87% for the smallest PV installations to 76% for the largest, while wind above 1.5 MW was to lose the generation tariff completely. In July 2018 the government announced that the FIT would be closed from April 2019.

Another important policy that affected renewable energy generation was about tax relief structures/venture capital schemes and certain energy generation activities: in 2015 the government excluded subsidized generation of renewable energy by community energy organizations and activities from Enterprise Investment Scheme (EIS), Seed EIS (SEIS), and Venture Capital Trust (VCT), and from the future enlargement of Social Investment Tax Relief (SITR). These tax relief structures (EIS, VCT) played an important part in building the financial justification for investment in solar projects in the UK.

These changes provoked resistance from a wide range of actors, but their efforts had limited impact on policy, and there was a marked drop in the deployment of onshore wind and solar, while offshore wind capacity continued to grow. Demand for Corporate Power Purchase Agreements (PPAs) increased, which helped make the business case for some new onshore developments. Meanwhile, the costs of onshore wind and solar PV continued to fall, as did the cost of battery storage technology leading to the emergence of hybrid solar/storage sites and the first unsubsidized solar PV and wind sites. This led to the current era of the United Kingdom that can be marked as "subsidy free renewables" when the projects that were announced as subsidy free started happening (mainly solar).

From January 2020, the Smart Export Guarantee (SEG) scheme has been brought in to replace the FIT scheme, to encourage investments in renewable technology and reduce carbon emissions for achieving net zero carbon emissions by 2050. The scheme is seen as less lucrative/favourable. In contrast to FIT, SEG does not have a universal payment amount (must be above zero); there is a single payment for exported electricity compared to FIT which had two payments – for generated electricity and estimated exported electricity; payment tariffs depend on chosen electricity supplier rather than a fixed tariff; requires smart

meters capable of 30 min readings for exported electricity.

## 5. Discussion: Shifting patterns of temporality, authority, and tension in financing pathways

Looking inductively across our case studies and data, three distinct themes emerge that we elaborate on here: one of temporality, or fundamental changes in financing schemes over time; one on authority, and the decentralization and often distribution of control; and one on contestation, conflicts and tensions within financing regimes.

### 5.1. Temporality: Fundamental changes in financing over time

Studying temporality (i.e. the changes of a case over time) brings into focus salient underlying dynamics and drivers to financing. Sections 4.1–4.3 indicate that indeed the temporality of subsidization and financing in each of the three countries is complex, and irreducible to a single factor.

For example, over the period examined Poland shifted from a pattern of an absence of funding for renewables to public support all the way to a current boom in prosumers and more market based investment models. There are several important milestones that determined the direction of the field's evolution. Over this time, Poland gained access to European funds through Poland's joining the EU, and it introduced a legal status of prosumer within the RES Act (2015) and its further amendments (esp. 2019). An impactful "My Electricity" program offering subsidies to individual prosumers was also launched. Growing awareness of the climate crisis, air pollution related health issues, and of vibrant development of renewable energy technologies, created certain public and civil pressure on Polish governments and legislators. External (EU) and internal (public opinion, grassroots civic movements) stress undoubtedly played a role in the process of RES Act development and negotiating. Auction mechanisms, tax relief, net metering and finally prosumerism, all new in the Polish energy context, created opportunities for new actors (e.g., prosumers, first attempts to establish energy co-operatives, ESCO firms, PV service providers). Sharp growth of the number of prosumers in Poland since 2019 (resulted from the success of the "My Electricity" program) indicates that the trend will likely continue. However, subsidies are still the dominant financial instrument and Polish renewable energy market is still dependent on them.

In the Netherlands, over the last two decades, the energy system gradually shifted from subsidization towards financing. The effect of innovation stimulation subsidies such as SDE, SDE+ and SDE++ made renewable energy more profitable over time. This decreased the dependency of renewable energy on national subsidy mechanisms. The sale of utility shares around 2010–2012 opened up large regional energy funds for municipalities and regional authorities. This sale was accompanied with a market-oriented mindset in local authorities, arisen against the background of budget cuts in municipal budgets due to the financial crisis of 2008/2009. The temporality of Dutch subsidies belies shifting priorities and fundamental logics within the subsidy regime. It exhibits increasing for-profit logic within community as well as state spheres, and increasing privatization of the field. The liberalization had changed the government role towards stimulating a free market, rather than own and manage utilities and government's attitude towards RE, i.e. moving away from subsidization towards financing/investing (e.g. through Invest-NL).

In the United Kingdom, we see a similar political trend and an even greater contrast in evolution of subsidization for renewables, i.e. a notable shift from wanting to be the 'greenest government ever' to getting rid of subsidies and heading towards a 'subsidy-free' environment. This overall trend did coincide with the rise of community actors and the growing role of local authorities in financing renewable energy projects and a search for new business models. When the government subsidy policy for renewable energy has changed dramatically, the cuts to support for renewable generation was a 'shock' for the actors active in

relation to renewable energy and posed a particular threat to continued investment from the non-traditional actors. The threat to community energy and crowdfunding was particularly strong, and as some interviewees pointed out, *real damage was done to these sectors by the cuts. For community renewables it meant a serious slow-down in the formation of new groups and a move towards buying up existing operational renewable projects over constructing new ones. For some crowdfunding platforms this meant diversifying away from wind and solar PV.* A further blow for community energy specifically came in July 2016 when the UCEF was shut down early. Overall, in the UK, until market circumstances (in particular, falling costs of solar PV and wind) allowed the recent emergence of the ‘subsidy free’ phase, it was largely the presence of subsidies from the central government which enabled/incentivised any investment in wind and solar PV. On the other hand, there was a plausible connection between the removal of government subsidies and the rise in PPAs (contractual arrangements whereby an organization buys electricity for its own use more or less directly from specific generators), which offer a market based way to manage risk of investors in generation capacity.

Essentially, Poland shifted from low levels of subsidization to a relative abundance of subsidies, whereas the UK headed in the opposite direction, scaling back subsidies and placing more emphasis on viable business models. The Netherlands wasn’t as extreme in their temporality, but did see a shift in the instruments being utilized, from state subsidies towards more market based financing mechanisms.

## 5.2. Authority: Decentralization and shifting control

Each of our three cases also reveals changes in the institutional environment for renewable energy financing and increased ‘inclusivity’ of actors. This includes the increasing role for local authorities in financing renewable energy projects, institutional investors interested in opportunities associated with climate change, and small players e.g. citizens usually investing through share offers or crowdfunding.

In Poland, the actors financing renewable energy are represented by public institutions from different government levels offering grants and subsidies, but also individuals and companies. Among them, (1) state-level public institutions managing public funds, such as The National Fund for Environmental Protection and Water Management (NFEPWM), and respective Ministries; as well as (2) regional and local public institutions managing public funds on the level of voivodeships, cities, and municipalities. Significant proportion of the subsidies and loans for renewable energy, especially for the companies and municipalities, are distributed through the Regional Operational Program and managed on the level of voivodeships. However, The National Fund for Environmental Protection and Water Management is the most important actor responsible for management of these funds.

The rapid rise in the number of prosumers observed from 2019 shows the impact of the subsidy program “My Electricity” addressed to individual households. For the first time, Poles on a mass scale decided to get involved in energy prosumerism. Although the forms of subsidy and of preferential loan are dominant, we observe a growing number of actors who try to introduce new and innovative financial models, such as energy investment cooperatives or Energy Performance Contracting (EPC). Rising energy prices and transposition of RED II directive are likely to strengthen this trend in 2021 and beyond.

It is also expected that the legal status of collective prosumers will be introduced in the upcoming amendments to the RES Act, in order to facilitate the use of the prosumer mechanisms by multi-family buildings residents.

In the Netherlands, decentralization occurred on two instances: an increasing role for decentral authorities and the increasing acknowledgement of citizens as important players in the energy transition. Firstly, local and regional authorities gained substantial financial resources to direct the energy transition through the sale of their utility shares. This sale led to the rise of regional energy funds. These funds

radically shifted the role of the local and regional governments, from a small player holding utility shares in the wings of a national subsidy scheme, to a central player with vast funds to finance the energy transition. Furthermore, local and regional authorities were institutionalized as important players in realizing the energy transition in the national Energy Agreement of 2013. The regional energy funds and the Energy Agreement put the local and regional governments as central players in the energy transition.

Secondly, citizens have become an increasingly important player in financing the energy transition through participation in energy co-operatives and crowdfunding. The institutionalization of citizen participation in the Energy Agreement of 2013 gave citizen engagement another impetus. After that, other actors, such as banks, started to consider cooperatives as professionals. Nevertheless, the Dutch crowdfunding sector remains small, despite efforts to professionalize through a trade organization. This is mostly because of the countervailing power of the vast financial sector and increasingly little encouragement from the national government after 2016.

The professionalization of the crowdfunding sector and energy co-operatives in particular has transformed the cultural-cognitive beliefs/norms that incumbent parties had towards citizen engagement. For example, as explained by one interviewee, the general attitude of banks towards citizen engagement changed, considering them no longer as ‘private individuals’ but as professional business customers. “*who, together, become so professional that they can take on quite large projects*”.

Finally, in the United Kingdom, there is a diversity of actors and shifting forms of control as well. The actors that were entering the renewable energy finance over the period covered in this study, are connected with different institutional fields, and different financial and subsidy mechanisms. It is particularly interesting to see the activities of non-traditional actors whose role in renewable energy finance was becoming more prominent at certain stages of development, in response to some policy changes or changes in the institutional environment (e.g. financial markets).

For example, after the Community Energy strategy 2014 was published, the government encouraged local authorities to support community energy projects, and to be more active in energy provisions more generally. This led to the increasing role for local authorities in financing renewable energy projects. Institutional investors also started playing a big part after 2014, e.g. UK local authority pension funds, insurance and pension company; by 2018 private institutional investors had started to take substantial shares of projects still under construction. The development of financial mechanisms empowered small players (e.g. citizens) offering investment opportunities and ways to support renewable energy. The rise of crowdfunding (as well as community energy projects) resulted in increased citizen engagement in financing wind and solar projects and changed the role of citizens from consumers to investors. Although the investor role itself was not new to the field but it was innovative in respect to citizens. This illustrates a change within the current system of roles. Another example is the change in the government’s role as a provider of financial support as the sector was moving to subsidy-free renewables.

A final insight related to authority and control is a tension between European pressures and policies and local and national pressures and policies. In some instances, such as the European wide emissions trading scheme, European Union efforts have a synergistic effect on renewable energy, helping promote wind and solar within particular sectors and industries. In this way, national mechanisms implement European directives, especially Directive 2009/28/EC that mandated levels of renewable energy use within the European Union from 2009 to 2021. However, such top-down pressure from the European Commission is significantly shaped by national and sub-national policies and the ad hoc goals of governmental and central agencies—a trend that helps explain why each of our three countries pursue different financial mechanisms pathways but also have very different characteristics (Poland intervening in its market vacuum to try to catch up in terms of its renewable



energy policy; the Netherlands moving from state support to tends; the UK seeking to minimize public support for renewables in lieu of private sector involvement). This reminds us both that varied financial mechanism configurations can respond to local needs but also hinder diffusion [66].

In sum, our three cases reveal how renewable energy financing represents not only a site of investment or financial disbursement, it also becomes a site of polycentric involvement with the scope to engage with consumers and communities themselves. Poland sees a strong rise in prosumers via their “My Electricity” program; the Netherlands in public-based crowdfunding; the UK – crowdfunding and efforts at stimulating community energy.

### 5.3. Contestation: Tension and conflicted development

Studying contestations (i.e. disagreements between actors) allows us to also study the winners, losers, and ever shifting power relations involved in financing efforts. Perhaps due in part to the temporal dynamism inherent in subsidy and financing trends, and also to the shifting contours of control and authority, each of our cases also see salient degrees of contestation and at times even conflict.

In Poland, the introduction and evolution of different financial and investment mechanisms for renewable energy depended on the evolving public policies, which often provoked heated debates and contestation. The two most important voices in these debates represent, on the one hand, advocates of sustaining the status quo – both in regards of dominant fuel type and organizational structure of the energy system, and on the other hand – advocates of evolution towards decentralized and low-carbon energy systems. For decades, the first position was dominant, which was reflected in the limited support for renewable energy development.

The struggles for the final shape of the RES Act in February 2015 represents this tension well. After years of delay under the government of liberal-conservative Civic Platform (PO) party in coalition with the agrarian Polish People's Party (PSL), the Act was accepted months before the next election, in October 2015, and was to come into force in January 2016, after the election. The Act provided the legal definition of prosumerism. The system of the prosumers' support raised controversies. Supporters of decentralization of the energy system lobbied for FIT as the best system of encouraging private investments in RES. Greenpeace was one of the organizations engaged in campaigning for this solution. A broad coalition of social actors, such as NGOs, agriculture and rural organizations, Association of Rural Municipalities, and Polish Economic Chamber of the Electromechanical Industries supported FIT, while incumbent energy companies were against it. The main ruling party, Civic Platform, did not support this solution and proposed net-metering instead. However, its coalition partner PSL voted together with opposition to pass FIT. The main author of the critical amendment (so-called “Bramora's Amendment”), PSL MP Artur Bramora, presented this financial mechanism as an opportunity for wide civic participation in energy production, particularly attractive for residents of rural areas, that is, PSL traditional electorate. FIT with guaranteed prices for 15 years was intended to enable prosumers to use traditional bank loans to cover investment costs.

Assuming that law would have come into force as planned, some land owners decided to invest in the PV micro-installations. However, after the parliamentary election in 2015, conservative-populistic party Law and Justice (PiS) formed the new government and, despite the fact that they supported FIT while in parliamentary opposition, few months later they withdrew their support and enacted a net-metering system instead of FIT. That undermined the trust of the actors connected and dependent on the SIE-field of finance and investment mechanisms, such as potential prosumers, firms from the sector, and commercial banks granting loans for PV micro-installations. Lack of trust and transparency in the process of policy-making remains an important problem in the relations between policy-makers and other actors in the field.

The Act on Investments in Wind Farms 2016, which has substantially slowed down wind energy in Poland, also illustrates some controversies over wind energy developments. The new law was officially motivated by the health and safety concerns and the public protests against wind turbines in the neighbourhoods. However, the social protest had very limited scale. It seems likely that the growing wind capacity was difficult to absorb by the grid operators, while the low electricity prices in windy periods posed unwanted competitions for incumbents.

In the Netherlands, contestation is especially prevalent around topics of subsidization, ownership and liberalization. For example, contestation arose around the emergence of regional energy funds. According to left-wing politicians, unbundling the regional and local energy authorities would lead to an influx of international influence in local areas. According to those in favour of the sale, the liberalization of the energy authorities would end an era of ‘being mad-Hank’ and the beginning of an era of being ‘smarter with money’, according to an alderman of Amsterdam as cited in a newspaper article by Verbraeken & Trappenburg [54].

Furthermore, contestation arose around the launch of national promotional bank Invest-NL. Here, the argument was posed that a national promotional bank and the subsequent centralisation of financial government institutions would lead to a more efficient financial instrument. However, as noted by one interviewee, *the centralisation of these institutions was prohibited by the institutions in question because the high-placed officials of these institutes did not want to lose their power and position within the energy system.*

Lastly, there have been several contestations around crowdfunding over time. In the beginning, the Ministry of Economics (MoE) and the Authority Financial Markets (AFM) wanted to allow plenty space for the novel instrument to develop, and allowed for regulatory derogation that enabled crowdfunding platforms to develop. However, an interviewee stated that *around 2016 the MoE and AFM became increasingly sceptical about crowdfunding platforms, as they started to perceive them as a potential threat to unknowing citizens. As such, the regulatory space of crowdfunding platforms was retracted as they became more intensively supervised and regulated by the AFM.*

The UK case clearly demonstrates that field actors often have diverse and contradictory aims and interests, with main contestations provoked by policy and regulation changes. When a series of policy changes significantly cut subsidies for the development of new onshore wind and solar PV installations, this resulted in expressions of concern, objections, and push-back from field actors ranging from institutional investors to community energy groups, but there were differences in emphasis in the responses reflecting different interests, and differences in the arguments they used to make their case, reflecting their different capacities. While the policy changes provoked resistance from a wide range of actors, their efforts had limited impact on policy, and there was a marked drop in the deployment of onshore wind and solar, while offshore wind capacity continued to grow. Institutional investors were among those with concerns about the turn taken by the government's renewable energy policy. The adoption and use of crowdfunding platforms that started providing finance for renewable energy generation projects, was also affected by changes in government support which reduced investor confidence, and proved especially challenging to the crowdfunding platforms, leading to stakeholder conflict.

Another example is when a change in the regulation of Cooperatives in 2014 caused disruption and was particularly disturbing to some existing energy cooperatives. Legislation in 2010 and 2014 had introduced Cooperatives and Community Benefit Societies as the successors to Industrial and Provident Societies. In brief, community benefit societies exist for the benefit of the community while cooperatives exist for the benefit of their members. The difficulty arose when the Financial Conduct Authority stopped allowing energy cooperatives to register as Cooperatives in 2014 and questioned the legal status of those which already had. The debate turned on the extent to which an organisation must trade goods or services with its members to be considered a bone

fide cooperative – renewable electricity coops generally do not sell electricity to their members for practical reasons [67]. According to one interviewee, *there was a divergence of view within the cooperative movement. Cooperative renewable electricity generators found themselves on one side of an 'ideological' contest within the wider co-operative movement and, to their frustration, found the FCA aligned with the other side.* In response to this, they were able to enlist the support of figures within the broader co-operative movement but, so far, to no avail. This contest was not over the inclusion of electricity generation activities per se, but rather the extent to which a co-op must trade with its members, something which the structure of the electricity market makes difficult for co-operative generators.

To summarize, even though renewable energy systems have plentiful economic, social, and environmental benefits briefly mentioned in Section 2, financing patterns towards them are not free from conflict. All three of our cases, even those with very large sources of offshore wind (UK) or onshore wind and solar (NL) exhibit battles and contestations between actors such as banks, government ministries, civil society groups, investors, hosting communities, and even energy users themselves. Financing thus not only redistributes money, it shifts politics and power, making it inherently contested.

## 6. Conclusion

Our comparative, mixed-methods assessment of financing and subsidies for renewable energy in three European countries yields fruitful insights concerning renewable energy, innovation, and policy.

First, the trends behind financial mechanisms for renewable energy are both complicated and fast moving. It is not only technological parameters and balance of system costs for wind and solar that are dramatically changing; the field of how such technologies are financed is complex and constituted by a number of sub-fields and institutions concerned with changing social relations in connection to financing of wind and solar that can be part of other fields, i.e. 'municipal energy'; 'community energy'; 'investment-based crowdfunding'; 'institutional investment in green infrastructure'; 'corporate' and 'private wire' PPAs. Although some discuss how subsidies can impede innovation, in our cases subsidies represent more enabling than impeding factors. This finding also resonates strongly with global trends in renewable energy financing, where capital markets, bonds, and other financial institutions are beginning to invest in the sector (and divest from other sectors, notably fossil fuels). In simpler terms: the diversity of financing instruments and increase in financing volumes are commensurate with global goals of decarbonization and climate change mitigation.

Secondly, our analysis reveals important patterns of innovation. Our cases show not only traditional financial mechanisms employed for the new goal, that is, enabling newcomers to conduct investment in renewable energy and thus engage in energy transition, but also entirely new, innovative, market-based financial mechanisms. Subsidies and preferential loans are used to develop and support new energy sources, and to enable new actors to get involved in energy production. Their innovativeness resides in the creation of a more dispersed and decentralized energy system. For instance, their prevalence in Poland results from a relative underdevelopment of the field (compared to NL and UK case studies), relatively low level of financial saturation and, above all, still quite restricted regulatory conditions in the Polish energy sector. Moreover, new financial mechanisms are challenging normative and cognitive institutions around renewable energy generation – their institutionalization is germinating into 'social standards' that seek to address the social dilemma of climate change mitigation. This form of institutionalization allows for legitimization of new actors participating in financing renewable energy (citizens, local authorities), making them more accepted and trusted by incumbents.

Third, determining the effectiveness of any particular set of financial mechanisms is difficult not only due to the complexity of establishing causality between a mechanism and diffusion (because the timing of

many mechanisms overlaps); but also due to national variation in terms of financing over time; shifting control and ownership; and tension and contestation in financing pathways. The efficacy of financial mechanisms in this way depends on maturation and cost of technology, but also wider institutional context (e.g. market-based economy vs transition economy). It is determined partly by technology, partly by institutions, partly by policy, and partly by country context.

Fourth, and lastly, our studies offer insight for policymaking and regulation. The available forms of financial mechanisms in our three European countries are strongly dependent on state policy and specific legislation. This means that the ability for actors other than the state to create transformative change throughout the financial sphere is limited, i.e. power is more constrained and circumscribed. State planners and government bodies often have direct control over public funds and different forms of public subsidies and loans. Indirectly, policymakers influence renewable energy finance by shaping organisational aspects of renewable energy (e.g. regulating energy co-ops) or setting the rules for the financial market (e.g. around tax relief/venture capital schemes). The involvement in developing innovative financial mechanisms often demands institutional work, such as pioneering new practices, lobbying and campaigning for/against relevant policy and regulation. In this way, the institutional environment and its governance dynamics can be just as important as the specific technology being subsidized, or the particular forms of innovation being harnessed.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Acknowledgements

The research leading to these results has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 837498 (SONNET - Social Innovation in Energy Transitions). We thank Alicja Dańkowska for her contribution as a research assistant to Poland's case study, and Naomi Schrandt and Sarah Rach for their contributions on the research on the Dutch case study.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.esr.2021.100730>.

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